STUDIES ON THE VOLATILE FATTY ACIDS IN THE RUMEN OF THE GOAT II. INFLUENCE OF UREA

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II. INFLUENCE OF UREA

By

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Introduction

Shaw *et al.* (1, 2, 3) have demonstrated that the molar proportions of the rumen volatile fatty acids (VFA), especially acetic acid and propionic acid, can be controlled by diet to a remarkable degree, and that the molar proportions of these two acids are closely related to the fat content of milk. For example, it was noted that the addition of either cod liver oil or linoleic acid to the diet of cows markedly decreased the acetic/propionic ratio and increased the total rumen VFA concentration. This was accompanied by large decreases in the fat content of the milk (4). On the other hand, Belasco (5) observed that urea as the sole nitrogen source in the artificial rumen promoted the formation of higher levels of propionic acid and lower levels of butyric and valeric acid than nitrogen equivalent amounts of high protein feed such as soybean, linseed and corn glutenmeals, but that the acetic acid level and total quantity of VFA were unaffected by the type of nitrogen substrate. The experiments described in this report were carried out to investigate the effect of the urea on the composition of VFA in the rumen of the goat.

Experimental

Three Saanen goats with rumen fistula, No. 5, No. 6 and No. 11, were used in the present work. Goat No. 5 and No. 6 were fed on the basal diet I, and No. 11 received the basal diet II, both diets consisted of 150 g wheat bran, 150 g barley and 800 g hay. Though the same kinds of feeds were used in both diets, their chemical composition slightly differed from each other. Diet I contained a little more crude protein and smaller amounts of crude fiber than diet II. Feeding regime and proximate analysis of the basal diets are given in Table 1, and Table 2.

Table 1. Feeding régime

Period	Time	Feeds
Control	1 P.M.	Wheat bran 150 g + barley 150 g + hay 500 g
	4 P.M.	Hay 300 g
Experimental	10 A.M.	Urea 6 g (injected into the rumen)
	1 P.M.	Wheat bran 150 g + barley 150 g + hay 500 g
	4 P.M.	Hay 300 g

Table 2. Percentage composition of basal diet, and experimental period

Basal diet	I	II
Crude protein	12.37	10.78
Crude fat	4.12	2.36
N. F. E.	49.68	47.23
Crude fiber	24.63	31.72
Ash	10.25	7.91
Control period	Nov. 22, '58～ Dec. 2, '58	Dec. 26, '59～ Jan. 6, '60
Experimental period	Dec. 3, '58～ Dec. 15, '58	Jan. 7, '60～ Jan. 21, '60

In addition to feeding the basal diet, 6 g of urea was injected into the rumen every day at 10 A. M. during the experimental period. Rumen liquor of the goat was gathered by a catheter through the fistula and centrifuged immediately. Twenty three milli-liter of the supernatant was added to 2 ml of saturated mercuric chloride solution, and the mixture was preserved in a refrigerator. The composition of VFA was determined by column partition chromatography as described in the previous report (6).

Results

Fig. 1 shows the variation of acetic acid concentration in the rumen liquor of goats, No. 5 and No. 6. The influence of urea injection upon the acetic acid concentration was obscure till 16:00, but the difference at 17:00 was a little noteworthy. The variation of propionic and butyric acid concentrations in the rumen liquor are shown in Fig. 2 and 3 respectively. The influence of urea injection was more obscure in both cases of propionic and butyric acids than that of acetic acid.

The variations of acetic, propionic and butyric acid concentrations in the rumen liquor of goat No. 11 are shown in Fig. 4. The change of each acid

concentration was very remarkable after feeding, and a little increase was observed after urea injection, but there exsisted no remarkable difference between the control and the experimental period. From Fig. 5, it should be noticed that urea tends to raise the pH values of rumen liquor. Fig. 6 summarizes the variation of molar percentage of each individual acid. Urea injection had no effect on the molar proportion of the VFA in the rumen liquor of goat No. 11.

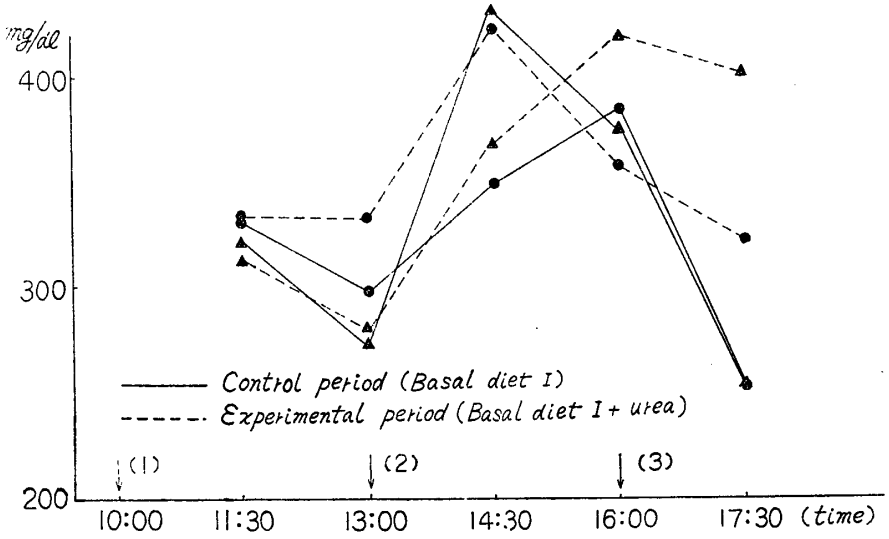

Fig. 1. Variation of acetic acid concentration in the rumen liquor.
(1) Urea administration (2) Feeding (3) Feeding
● goat No. 5, ▲ goat No. 6

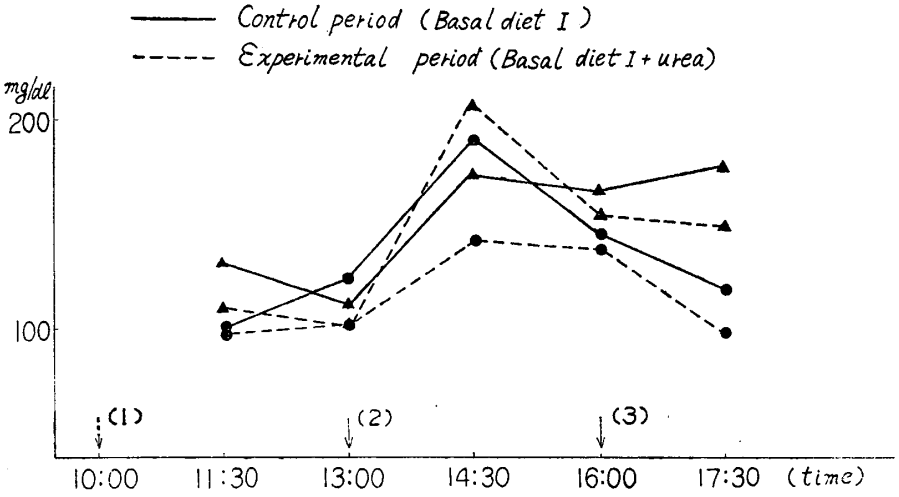

Fig. 2. Variation of propionic acid concention in the rumen liquor.
(1) Urea administration (2) Feeding (3) Feeding
● goat No. 5, ▲ goat No. 6

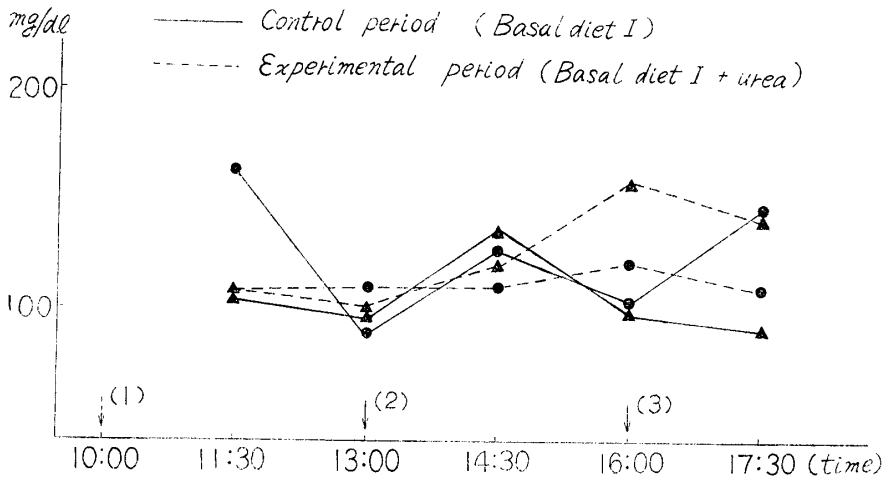

Fig. 3. Variation of butyric acid concentration in the rumen liquor.
(1) Urea administration, (2) Feeding, (3) Feeding
● goat No. 5, ▲ goat No. 6

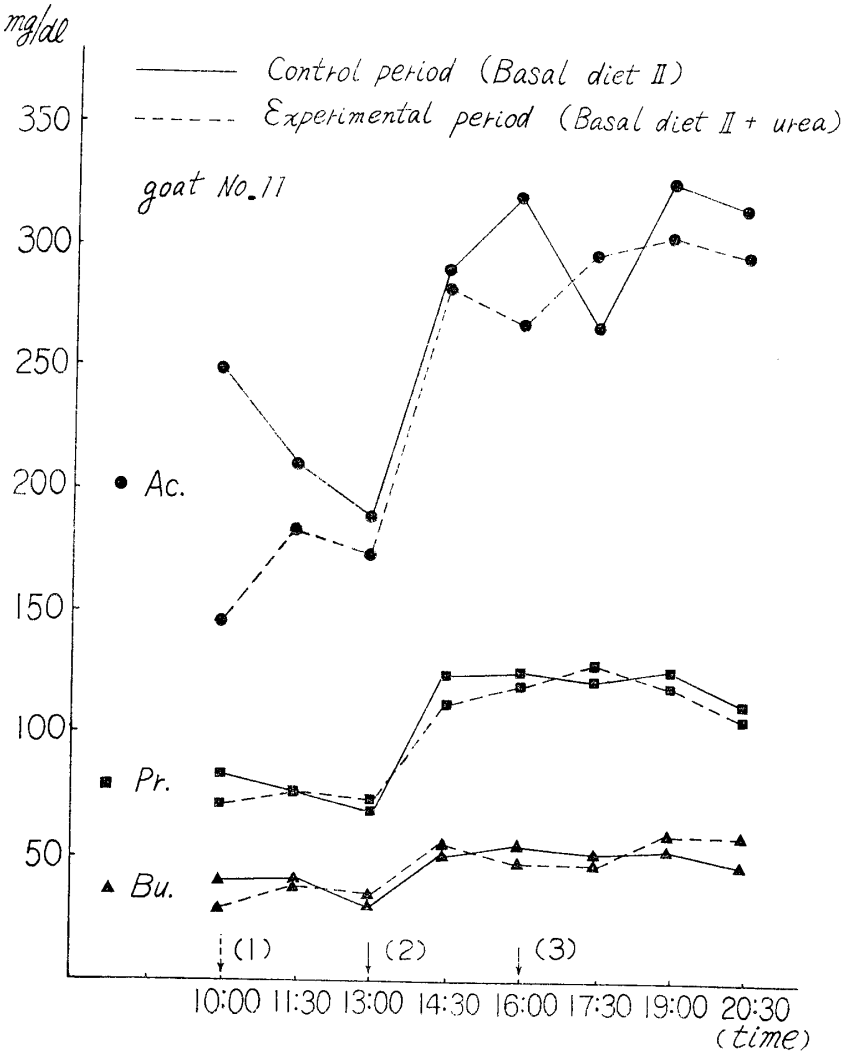

Fig. 4. Variation of each acid concentration in the rumen liquor.
(1) Urea administration, (2) Feeding, (3) Feeding

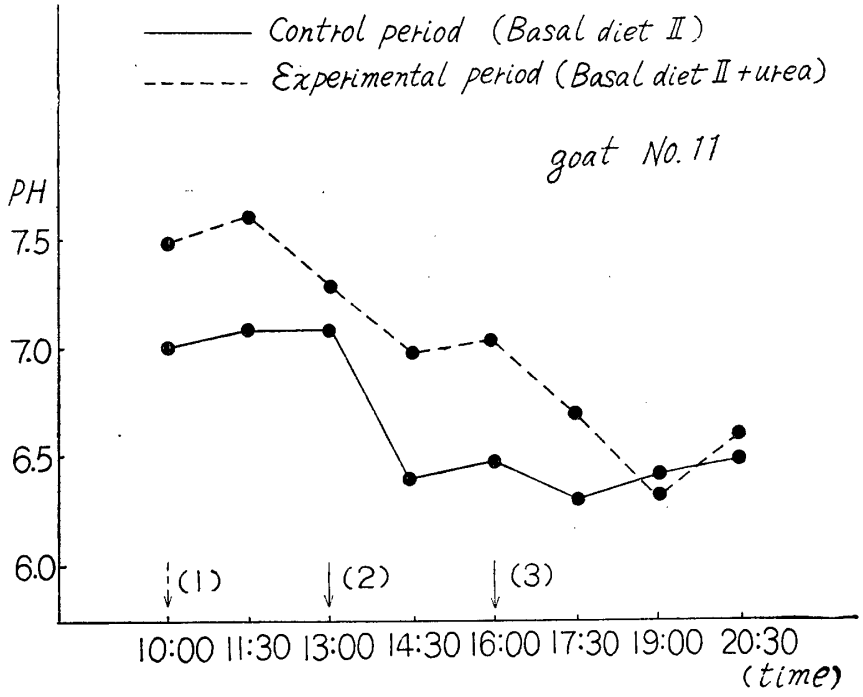

Fig. 5. Variation of pH in the rumen liquor.
(1) Urea administration, (2) Feeding, (3) Feeding

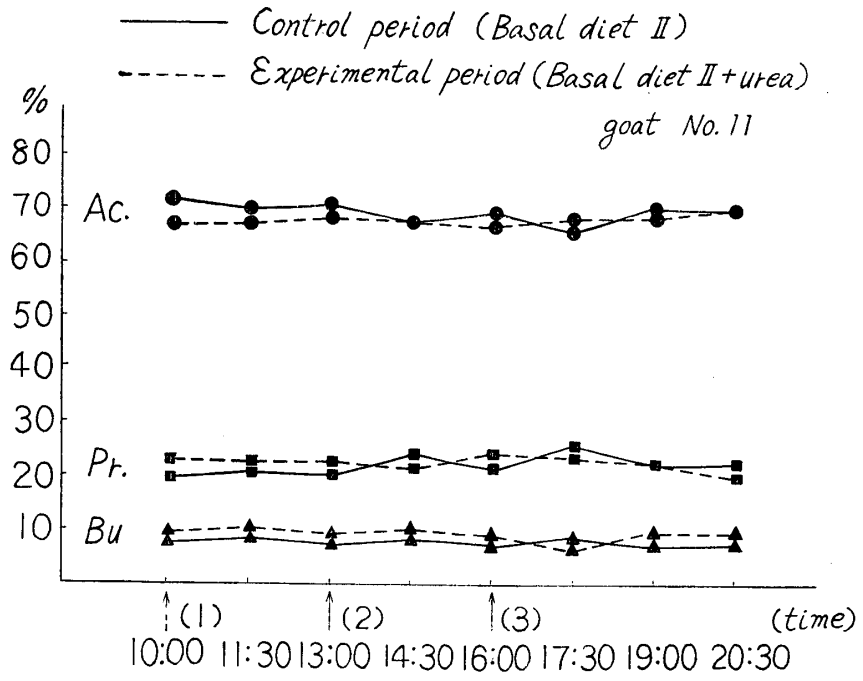

Fig. 6. Variation of VFA composition in the rumen liquor.
(1) Urea administration, (2) Feeding, (3) Feeding

Discussion

It is well established by both experiments, ***in vivo*** and ***in vitro*** that acetic, propionic and butyric acids are the main components of the volatile fatty acids which are produced by rumen bacteria. But, several workers have observed that the acetic/propionic ratios obtained in the ***in vitro*** experiments show smaller values than that normally found in the rumen contents (7, 8). The difference of these values between *in vitro* and *in vivo* experiments are always very remarkable. Gray and Pilgrim (9) concluded that the smaller proportions of propionate found in the rumen contents reflected the more rapid absorption of this acid from the rumen. But, the additional information now available on the absorption of rumen volatile fatty acids provides no support for this view (10). Hueter *et al.* (11) compared ***in vivo*** and *in vitro* techniques in ruminology studies and concluded that *in vitro* technique appears most useful for studying short one- or two-step reactions presumed to occur in the rumen. This technique probably losses significance when studying multistep reactions. In addition to this, mention may be made here of the restriction of urea as a nitrogen source in the ruminant diet. Numerous reports, as reviewed by Reid (12), indicate that urea should not supply more than 30—40 per cent of the total nitrogen intake. Belasco (5) used urea as a sole nitrogen source in his artificial rumen, and in the present work, urea nitrogen supplied only 15—20 per cent of the total nitrogen. The explanation of the different effect of urea on the composition of volatile fatty acid probably lies in both the different conditions between ***in vitro*** and ***in vivo*** and the different amount of urea used as a nitrogen source.

Summary

Ordinary amounts of hay and concentrates were given twice a day, at 1 P.M. and 4 P.M., during a period set up for the control. In addition to feeding on this ration, six grams of urea were injected into the rumen every day at 10 A.M. during the experimental period for additional urea feeding.

The influence of urea administration on the volatile fatty acids compositions in the rumen liquor of the goat were examined. Molar percentage of rumen fatty acids were not affected appreciably by urea administration, but were affected by the chemical composition of the basal diets. In these studies it was also confirmed that the molar proportion of the rumen volatile fatty acids did not change appreciably with time after feeding.

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